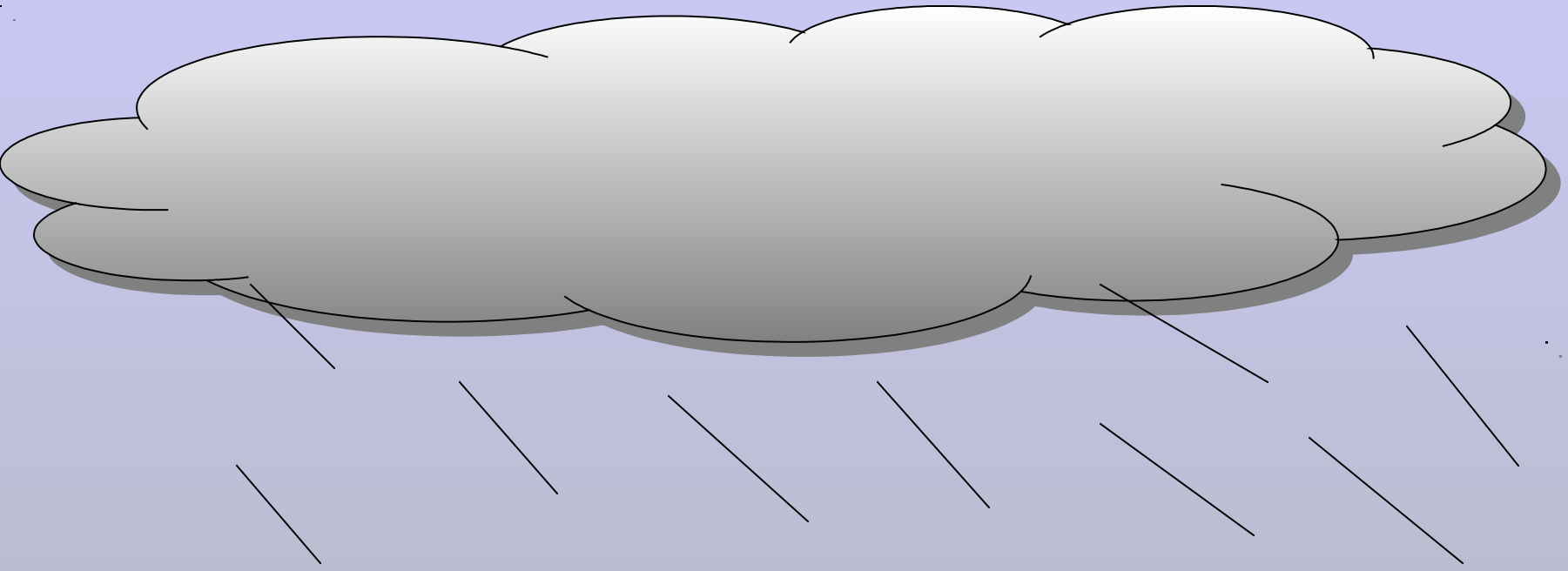
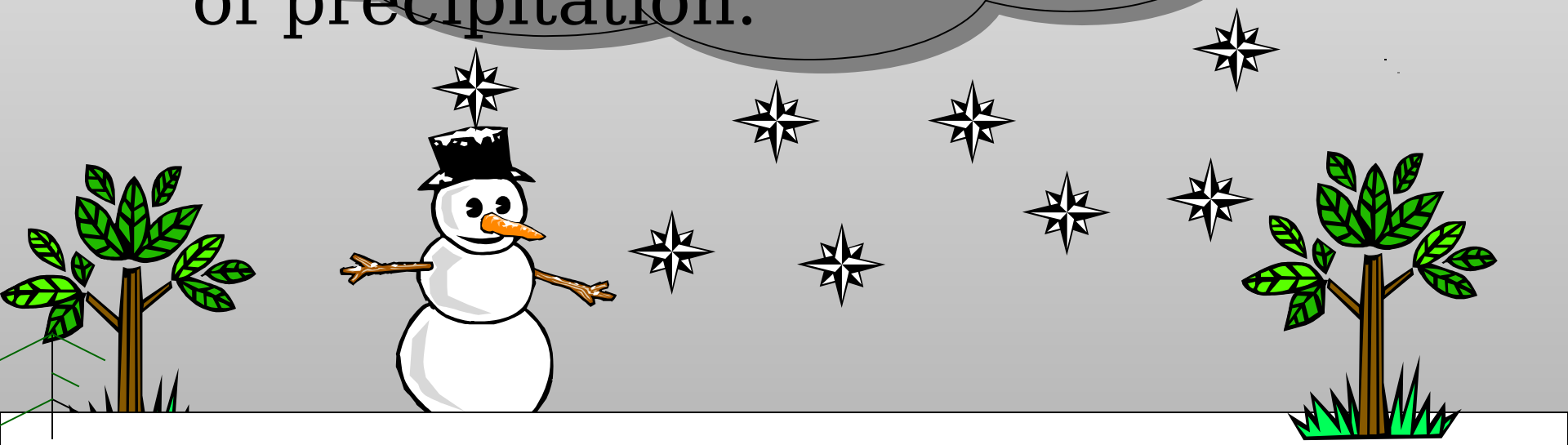


The Precipitation Process

PURPOSE OF CLASS

- The purpose of this presentation is to provide a comprehensible understanding of the various types of precipitation.



TERMINAL LERNING OBJECTIVES

- In accordance with the references, discuss in detail the various aspects that make up the precipitation process

ENABLING LEARNING OBJECTIVES

(1) Without the aide of reference, discuss the two processes that meteorologists have found that precipitation is formed through.

(2) Without the aide of reference, discuss the warm rain process and the cold rain process

(3) Without the aide of reference, identify and discuss the types of precipitation that occurs in both the warm rain process and cold rain processes

(4) Identify the seasonal precipitation types nd the atmospheric importance of each type of precipitation

(5) Identify and discuss two ways that meteorologists forecast precipitation

HOW PRECIPITATION FORMS

There are two processes in which meteorologists and scientists say precipitation forms:

1) Collision and Coalescence Process
2) Ice-Crystal Process

COLLISION AND COALESCENCE PROCESS

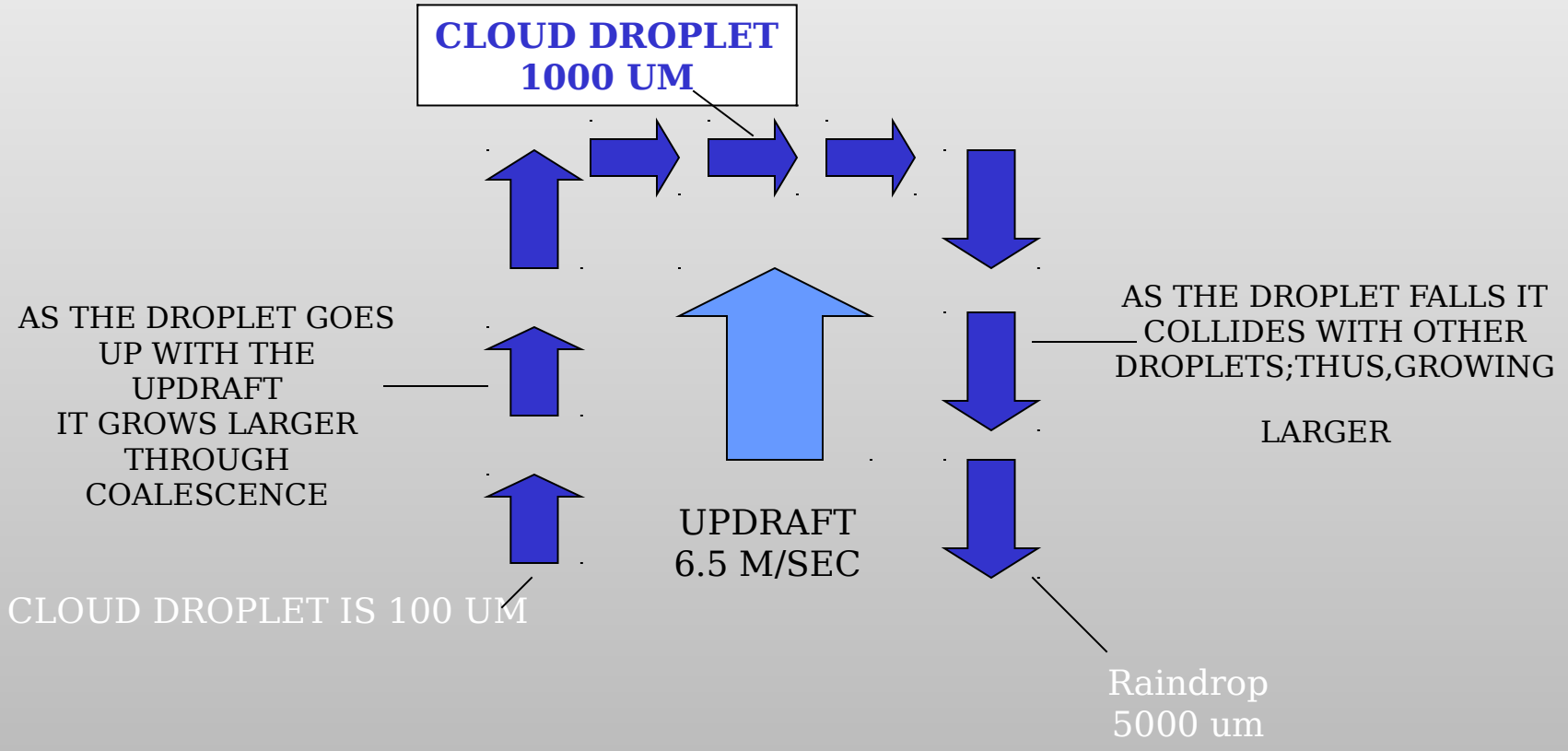
In a warm cloud (clouds formed in temperature above freezing), the collisions of minute cloud droplets creates larger droplets. This process is called coalescence. Coalescence helps to break the equilibrium of the atmosphere which keeps minute droplets suspended in the clouds. The droplets which combine together become large which sometimes makes them to become too heavy for the cloud updrafts to keep up. These droplets then begin to fall through the cloud as precipitation. As these droplets fall through the cloud they merge with other droplets which makes them even larger. Con’t. on next frame

COLLISION AND COALESCENCE PROCESS CON'T.

Sometimes these droplets will break apart or bounce off each other. It has been found that coalescence is further helped when water droplets are of different electrical charges.

If the air underneath the cloud is moist, than the droplet will reach the ground as drizzle. If the cloud is extremely high above the ground, the droplet will evaporate before reaching the surface.

Collision and Coalescence Diagram


CLOUD DROPLET
1000 UM
AS THE DROPLET GOES UP WITH THE UPDRAFT IT GROWS LARGER THROUGH COALESCENCE
AS THE DROPLET FALLS IT COLLIDES WITH OTHER DROPLETS;THUS,GROWING LARGER
UPDRAFT
6.5 M/SEC
CLOUD DROPLET IS 100 UM
Raindrop
5000 um

ICE CRYSTAL PROCESS

- The next precipitation process is a long one to discuss; therefore, I am going to break it down into the following four categories:

(1) Equilibrium

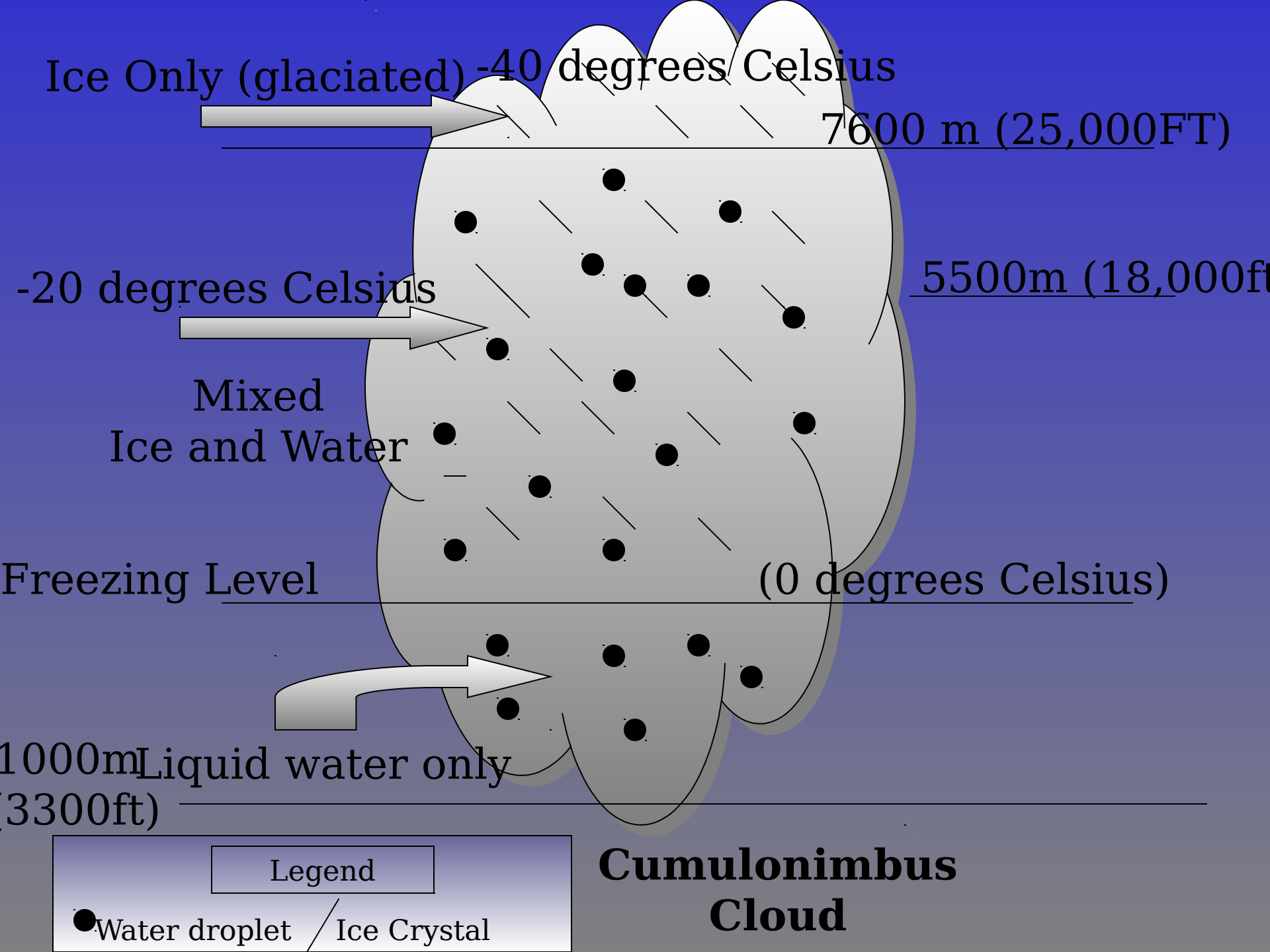
(2) Deposition

(3) Graupel

(4) Bergeron Process

ICE CRYSTAL PROCESS (Equilibrium)

- In a normal mixed cloud,clouds with both water droplets and ice crystals,many supercooled droplets will surround each ice crystal. Since the difference in vapor pressure causes water vapor molecules to move from the liquid droplets to the ice crystals, the removal of vapor molecules reduces the vapor pressure above the droplet. This makes the droplet go out of equilibrium with its surroundings and the droplet will evaporate to replace the supply of water vapor above it.


Ice Only (glaciated)
-40 degrees Celsius
7600 m (25,000FT)
-20 degrees Celsius
5500m (18,000ft
Mixed
Ice and Water
Freezing Level
(0 degrees Celsius)
1000m
(3300ft)
Liquid water only
Legend
Water droplet
Ice Crystal
Cumulonimbus
Cloud

ICE CRYSTAL PROCESS (Deposition)

- The process that makes the water droplet go out of equilibrium with the surrounding atmosphere allows the ice crystal to grow by deposition.Deposition is part of the water cycle and it is the change of water vapor to ice.The deposition process gives the ice crystals extra weight which allows them to become too heavy for the updrafts to keep afloat. Now we have ice crystals falling from the sky.

ICE CRYSTAL PROCESS (Graupel)

- When the ice crystals fall from the sky they collide with supercooled droplets. This causes the droplets to freeze on contact with the ice crystals. This process is called accretion or riming.The riming matter we now have is called graupel. As the graupel falls, it tends to splinter up into tiny ice particles as it collides with other cloud droplets. These droplets then turn into more graupel and the process continues.

ICE CRYSTAL PROCESS (Bergeron Process)

- In colder clouds, ice crystals may collide with other crystals and fracture into smaller ice particles. As these ice crystals fall, they may collide or stick together with one another. When they collide they form a collection of snowflakes called a snowflake. If the snowflake melts before reaching the ground, it will continue it’s descent to the surface as a raindrop. Therefore it seems that all precipitation that falls to the ground starts off as a snowflake. This theory is known as the Bergeron Process.

WARM RAIN PROCESS

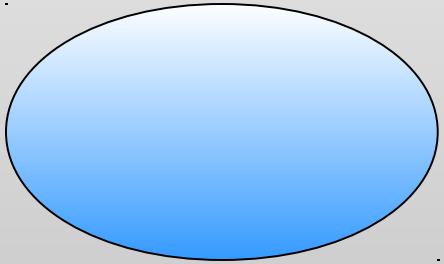
- **Clouds that form at temperatures warmer than 0 degrees Celsius are called warm clouds.**
- **The Collision and Coalescence process is what makes precipitation form at temperatures warmer than 0 degrees Celsius. This process can also be called the Warm Rain Process.**
- **Sometimes water droplets can form at temps. Lower than 0. These droplets are called supercooled droplets.**
- **The following types of precipitation are formed in the Warm Rain Process.**

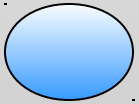
RAIN AND DRIZZLE

- **Defined as any falling drop of liquid water that has a diameter greater than 500 um (0.5 mm)**
- **Rain can either be showery or continuous**
- **Showery rain occurs in cumuliform form clouds**
- **Continuous rain occurs in stratiform clouds**
- **The atmospheric significance of showery rain is that it shows that the atmosphere is unstable in the lower atmosphere**
- **The atmospheric significance of continuous rain is that it shows that the lower layers of the atmosphere are stable**
- **Drizzle is defined as any falling drop of liquid water that is less than 500 um (0.5mm)**
- **Drizzle only occurs in stratiform clouds;thus, drizzle lets meteorologists know that the atmosphere is stable**

Difference between the two

RAIN: 0.5 MM OR GREATER



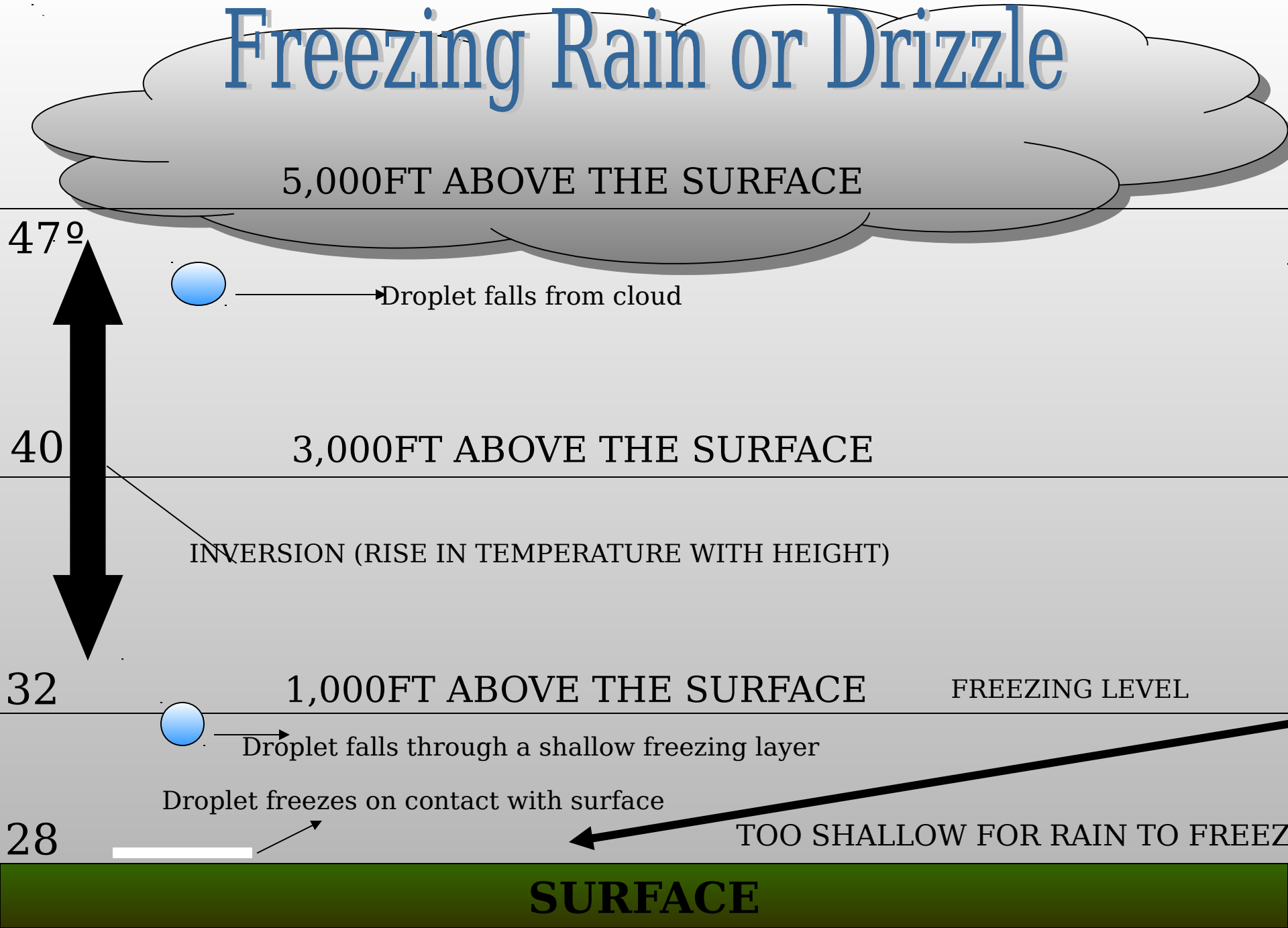


DRIZZLE: LESS THAN 0.5MM

FREEZING RAIN

- **When water droplets fall through a deep layer of cold air they usually fall to the ground as snow**
- **When the freezing layer beneath a cloud is shallow, there is not an ample amount of time for a rain drop to freeze before it reaches the ground;thus, the rain freezes instantaneously when it comes in contact with the below freezing surface.**
- **If this water droplet touches the body of an aircraft that is flying by, a layer of ice can form on the aircraft. When the weight of the icing becomes heavy enough, it can cause the plane to crash.**
- **Icing can cause the aerodynamics of a plane to change which can lead to an aircraft mishap**

Freezing Rain or Drizzle



COLD RAIN PROCESS

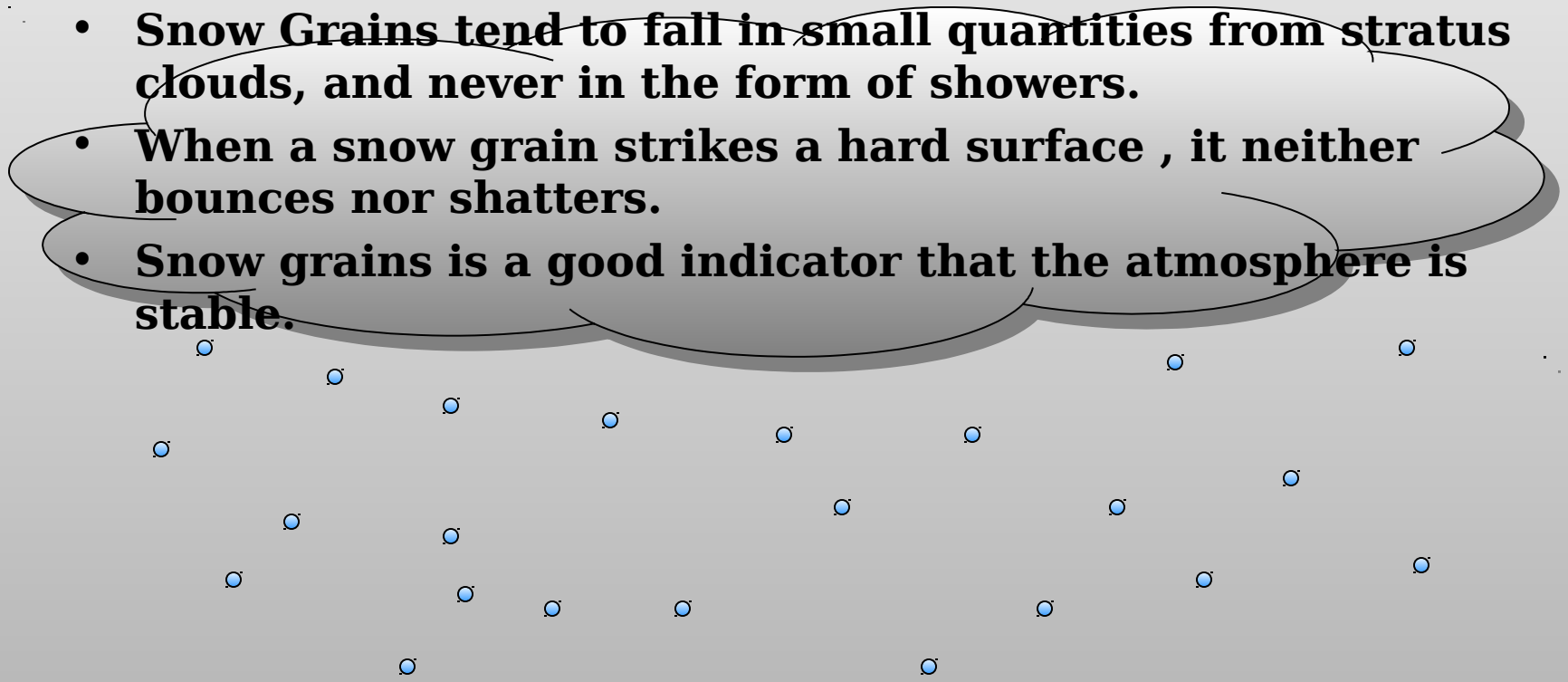
- Clouds that form in temperatures lower than 0 degrees Celsius are considered cold clouds
- As you can remember, the Ice Crystal Process is what makes precipitation form at temperatures colder than 0 degrees Celsius.
- The Ice Crystal Process can also be called the Cold Rain Process
- The following frames contain information about precipitation that is formed in the cold rain process:

SNOW

- In the winter time,when the freezing level drops to a lower extent than in summer, precipitation is able to fall to the ground as snow.
- Snow can usually fall 1,000 feet in above freezing temperatures before melting; therefore, one would want the freezing level to be less than 1,000 feet if they wanted to see precipitation fall as snow.
- When snow falls from cumulus clouds, they are known as flurries.
- Flurries usually only produce a small amount of precipitation.
- On the occasion flurries will become intense; this is known as a snow squall.

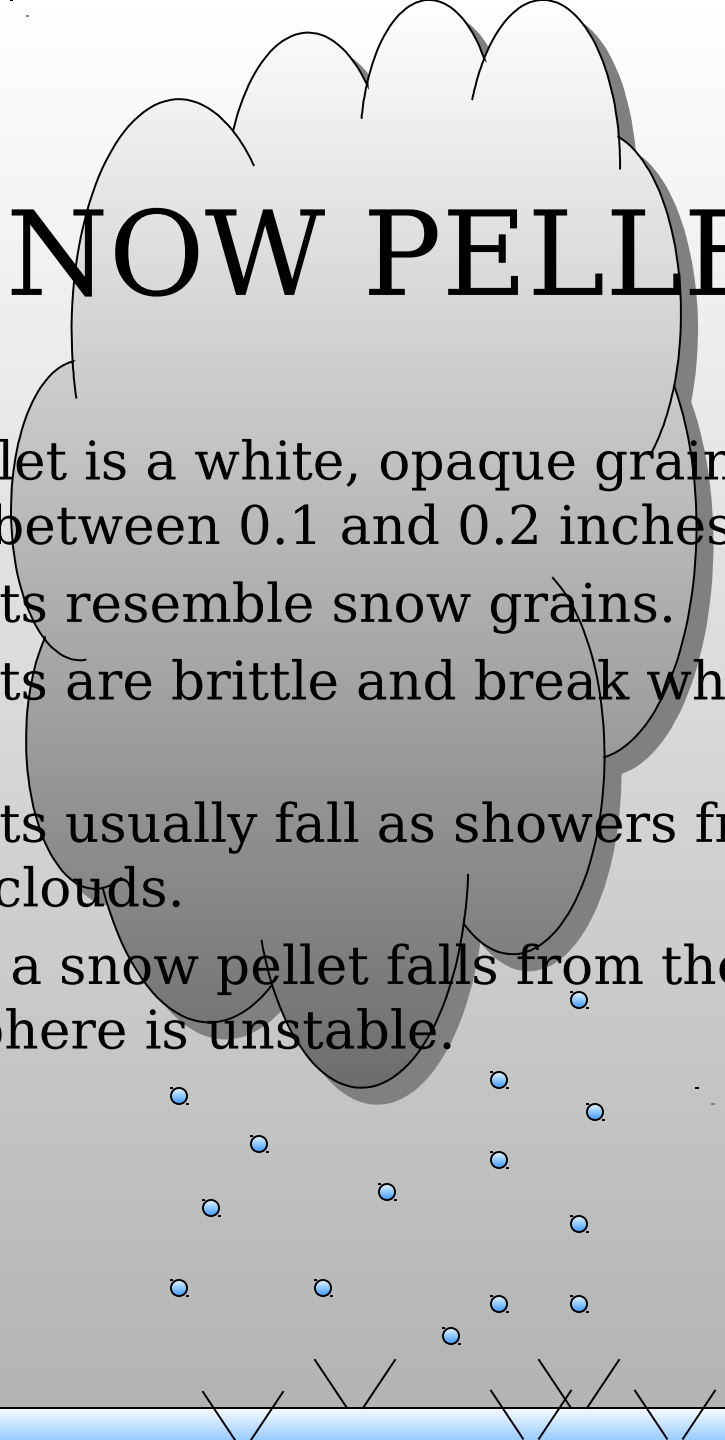
SNOW GRAINS

- **This form of precipitation is small, opaque grains of ice; they are the solid equivalent drizzle.**
- **Snow Grains tend to fall in small quantities from stratus clouds, and never in the form of showers.**
- **When a snow grain strikes a hard surface , it neither bounces nor shatters.**
- **Snow grains is a good indicator that the atmosphere is stable.**



SNOW PELLETS

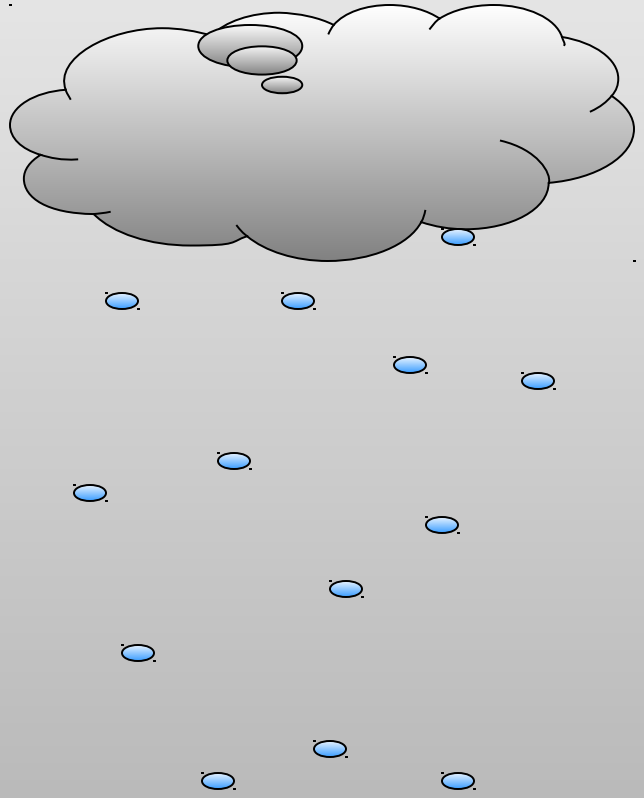
- A snow pellet is a white, opaque grain of ice, with diameters between 0.1 and 0.2 inches.
- Snow pellets resemble snow grains.
- Snow pellets are brittle and break when they hit the surface.
- Snow pellets usually fall as showers from cumulus congestus clouds.
- When ever a snow pellet falls from the sky it shows that the atmosphere is unstable.



IFFERENCE BETWEEN SNOW GRAINS AND SNOW PELL

SNOW GRAINS

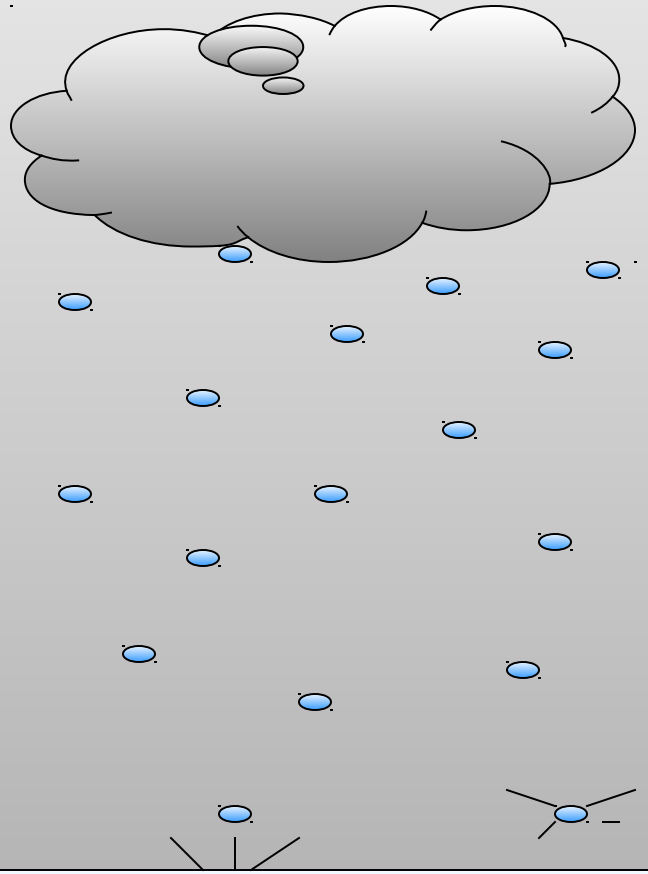
(Falls from stratiform clouds)



esn’t bounce or shatter when hitting surf

SNOW PELLETS

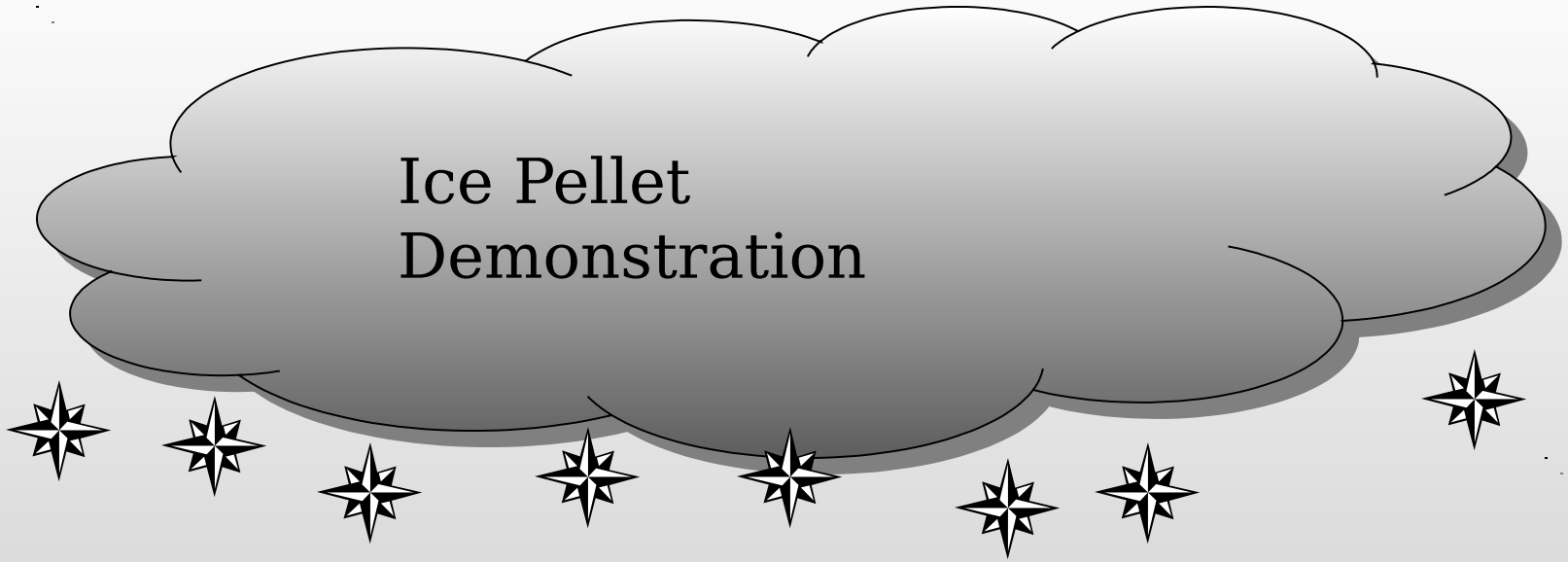
(Falls as showers from cumuliform clouds)



Bounces or breaks when they hit the surface

ICE PELLETS

- When snow falls into warmer air it will begin to melt and start a transformation from snow to rain
- If the snow falls back into a freezing level before it melts completely, it will become a piece of ice.
- These particles of ice have diameters 0.2 inches or less
- This form of precipitation is an indicator that there is an inversion,which is a rise in temperature with elevation, in the atmosphere



Temp: Below Freezing

Frozen

Temp: 35-45 degrees Celsius

Begins to melt

Temp: Below Freezing

Refreezes as ic

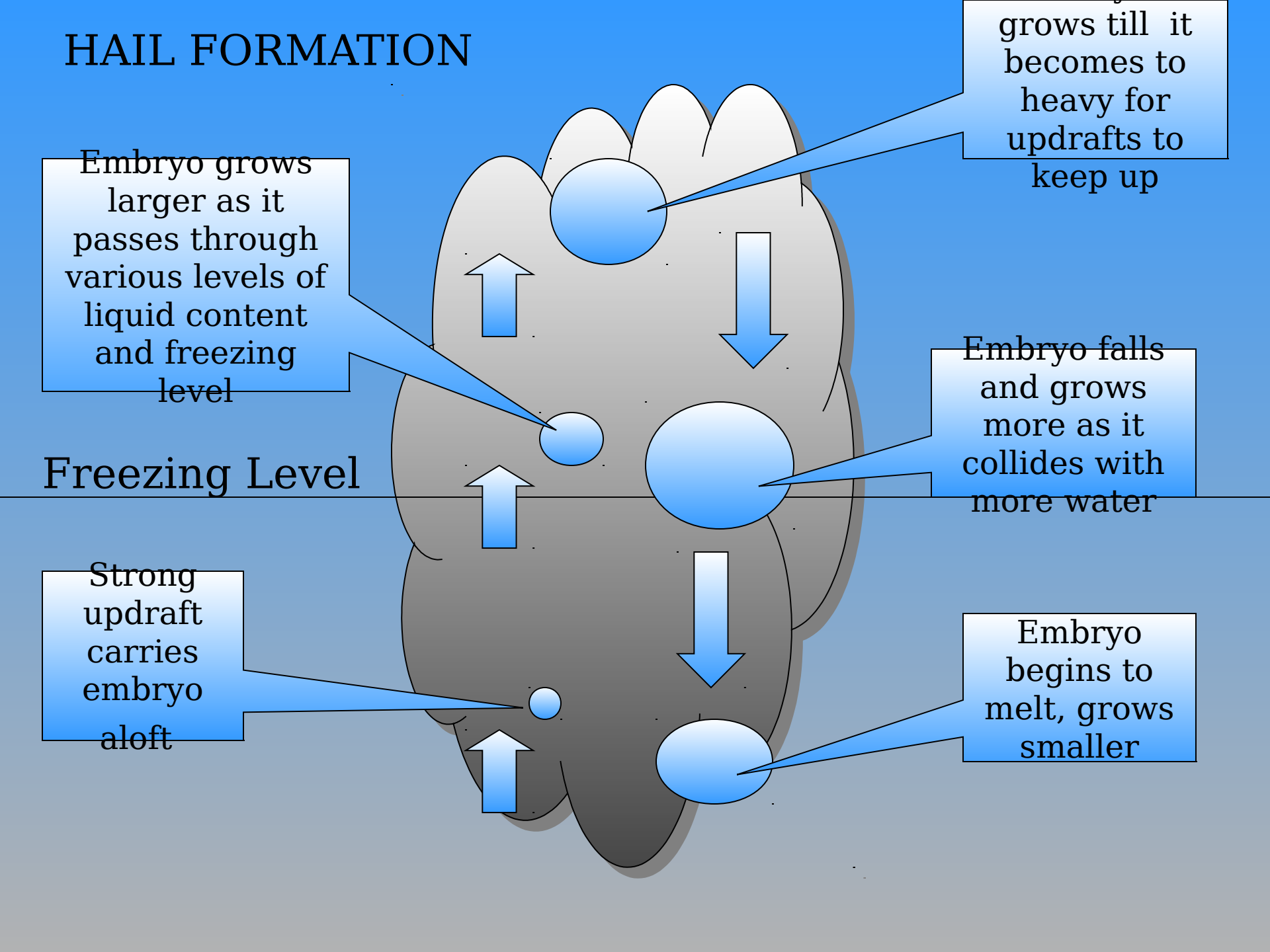
HAIL

- **Pieces of ice that are either transparent or partially opaque and range in size from small peas-to golf ball size, and sometimes larger**
- **Hail is produced in a Cumulonimbus cloud**
- **Hail is a direct indicator that the atmosphere is very unstable and that thunderstorms are present**

HAIL CON'T

Hail occurs when strong updrafts in the CB cloud carry small embryos high above the freezing level. As the embryo passes through regions of varying liquid water content, a coating of ice forms around them and they grow. When the ice particles are of good size, they become too heavy to be supported by the updrafts and fall as hail. If the updraft increases speed then the hail stone will be picked up and will go through the process again.

HAIL FORMATION


grows till it becomes to heavy for updrafts to keep up
Embryo grows larger as it passes through various levels of liquid content and freezing level
Freezing Level
Embryo falls and grows more as it collides with more water
Strong updraft carries embryo aloft
Embryo begins to melt, grows smaller

SEASONAL PRECIPITATION

To understand precipitation it is critical to understand that certain types of precipitation usually only fall during a specific time period or season

SUMMER & WINTER

- **SUMMER TYPES**

(1) **Rain**

(2) **Drizzle**

(3) **Hail**

WINTER TYPES

(1) **Snow**

(2) **Freezing Rain**

(3) **Freezing Drizzle**

(4) **Snow Grains**

(5) **Snow Pellets**

(6) **Ice Pellets**

SEASONAL PRECIP CON'T

- During the Fall and Spring there can be a mixture of precipitation types since both seasons can either be unseasonably warm or cold.

FORECASTING PRECIPITATION TYPES

- When forecasting precipitation, meteorologist will generally use two different ways to determine the type that will fall

(1) Thickness method

(2) Freezing level method

THICKNESS METHOD

- **Thickness is what forecasters use on most occasions to forecast precipitation types. Thickness is the vertical distance between two constant-pressure surfaces.**
- **It is a function of temperature: the warmer the air, the thicker the layer.**
- **The most widely used chart for determining precipitation is the 1000-to-500-mb thickness chart. On this chart forecasters use a thickness line called the 540 (5,400 meter) line. It has been shown in studies that snow is rare when the 1000-to-500-mb thickness is greater than 5,440 meters (544 line).**
- **The next thickness value used is the 0 degree Celsius 850-mb isotherm (line of equal temp).**
- **The last predictor using the thickness method is the 850-700-mb thickness line.**

1000- to- 850 mb

- Since the 1000-to-850 mb thickness is the most commonly used, it is the one I will go more in depth with
- The following table shows the values that forecasters use to determine what type of precipitation will occur (make a table for the following)

1000-500 mb Thickness value (m)	Type of Precipitation
> 5,400	Rain
< 5,435	Snow
5,385-5,435	Mixed Rain & Snow
5,330-5,520	Ice Pellets
5,330-5,520	Freezing Drizzle
5,330-5,440	Freezing Rain

FREEZING LEVEL METHOD

- Forecasters often use the freezing level to determine the type of precipitation that will occur. The assumption is that the freezing level must be lower than 1,200 feet for precipitation to reach the ground as snow. The following methods are ways to determine precipitation using freezing levels:

(1) Single freezing level

(2) Multiple freezing levels

SINGLE FREEZING LEVEL

- If the freezing level equals or exceeds 1,200 feet above the surface, forecast liquid precipitation
- If the freezing level is less than or equal to 600 feet above the surface, forecast solid precipitation
- If the freezing level is between 600 and 1,200 feet above the surface, forecast mixed precipitation

MULTIPLE FREEZING LEVELS

- When there are multiple freezing levels, warm air exist where the temperature is above freezing. The thickness of the warm and cold layers affects the precipitation type at the surface.
- If the warm layer is greater than 1,200 feet thick and the cold layer closest to the surface is less than or equal to 1,500 feet thick, forecast freezing rain.
- If the warm layer is greater than 1,200 feet thick and the cold layer closest to the surface is greater than 1,500 feet thick, forecast ice pellets.
- If the warm layer is between 600 and 1,200 feet thick, forecast ice pellets regardless of the height of the lower freezing level.